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VIZ_planner: A User -Centered Information Visualization System for Middle and High Level Production Planning Support

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Introduction

The intention of the this research is to strengthen organizations by helping middle and high level managers to achieve comprehension of their voluminous domain data so that effective decision-making can be achieved by managers. Instead of using their cognitive powers to figure out the stories behind voluminous domain data with complex relationships, managers can use computer-generated information visualizations to perceive what is going on in the data. This research on information visualization of non-geometric "data mining" is based on human characteristics. An easy to understand and use prototype system VIZ_planner has been development, tested, and empirically evaluated for improving human problem-solving performance in manufacturing production planning domain. Following are brief descriptions including the general problem areas this research has been focusing on, the specific area of manufacturing production planning problems, and the prototype system VIZ_planner.

General Problem Areas

Many business domains have the following characteristics: (1) There are large amounts of high-volume, non-geometric-based data that have to be dealt with in order to solve domain problems. Non-geometric-based data are not pictorial in nature and do not have an inherent geometric structure that can lead to a realistic-looking representation of the data. (2) The relationships among the data are complex and multi-dimensional. (3) In these domains, computers are vital in order to manage and calculate required data; however, the final decisions are made by humans. (4) The decision-making environment is dynamic, which requires decision-makers to understand as much as possible about problem situations and potential solutions. (5) Time pressure is a major concern, which requires decision-makers to make quick responses to upcoming events. Problem-solving in these business domains is overwhelming. Even with the support of existing computer systems, people still have to use their cognitive powers to figure out the "stories" behind the computer-generated reports, which could be as long as several hundred pages. Effective decision-making in these domains is rarely feasible. A concrete example is the following described manufacturing production planning problem, named the ECAT problem.

The ECAT Problem

ECAT, an electronic manufacturing company for personal computers, has vast quantities and multiple dimensions of data and constraints. The planning objective is to maximize overall revenue from the production subjects to available components and machine capacity. It has several hundred types of products, several thousand types of components, several assembly lines, tens of machines, and very competitive end product market. The plant had access to a mathematical programming system that could provide an algorithmic solution to the planning problem, yet the human planners considered that solution to be inferior to a manually generated solution. This was largely due to the flexibility of constraints and actions that could be taken but could not be represented easily to the algorithmic system. The planners' primary frustration was trying to hold these vast quantities of information in their heads while they were trying to develop a solution. We felt that if the data and constraints could be visually presented to these planners, they could develop superior solutions. Current decision support systems for production planning focus primarily on the presentation of data in a numerical format or simple one or two dimensional graphs.

Yet the planners were able to simultaneously manipulate many more constraints for each action being considered. The planners preferred the more information-intensive numerical tables to the charts. Pages of tables would be laid out over the floor and desk of each planner's office as s/he laboriously attempted to absorb the data. This presented an obvious opportunity for enhancement of the planning process through computer automation and visualization.

Technology Background and New Challenge

The word "visualization" means using computer-generated graphics to help people understand and clarify visually the relationships inherent in data. The information conveyed to a viewer by visualization undergoes a qualitative change, because it brings in the eye-brain system, with its great pattern-recognition capabilities, in a way that is impossible with purely numeric data. To date, nearly all applications to which this technology has been applied involve the visualization of systems that are naturally represented as two- or three-dimensional objects. Examples can be found in many scientific visualization applications, such as visualizing biological molecules, medical imaging, tracking and imaging elementary particles, etc. However, many of the most exciting potential uses of visualization technology involve visual representations of data that are not naturally represented as geometric structures in any obvious way. This means that the nongeometric-based data do not have physical-based interpretations or geometric structures that lead directly to computer supported representations. Most data in many business, health care, service, and even military domains are this type of data. An extensive literature review [Zhang 95] shows that little research has resulted in graphical representations of nongeometric, high-volume (i.e., with extensive elements for variables), high-dimensional management data for problem-solving support. The potential benefits of interactive visualization of the complex, nongeometric information in providing humans with insight into the complexities of domain data are significant. However, it is far from obvious how to visually represent the interaction of many factors that influence the domain processes in a way that will enable people to make better management decisions.

VIZ_planner for Manufacturing Production Planning Support

VIZ_planner is a prototype system for supporting production planning decision-making. Its underlying production planning system is based on MRP II process, a typical production planning process used by many manufacturers. It visualizes critical planning data as multi-dimensional visual images for decision makers to formulate problems, identify conflicts, generate alternatives, and evaluate potential solutions. By providing both "a forest" and "trees," it allows a planner to do what-if analysis to identify most effective actions to take in order to achieve satisfactory solutions.

VIZ_planner is not just for ECAT but for any place where the planning process is, or is similar to, the MRP II process. It runs under SUN Solaris 2.2 or higher with Openwin windows manager and contains more than 17,000 lines of C code.

Preliminary Empirical Verification

VIZ_planner was informally evaluated by real world planners from different manufacturers. A preliminary lab experiment with a simplified version of VIZ_planner was conducted [Zhang 96] to evaluate the effectiveness of the VIZ_planner system on problem-solving performance by using two groups of graduate students in a major university who have production planning background. The experimental results showed that users using VIZ_planner (1) generated more alternatives for solutions and (2) had more efficient changes in raw data in order to achieve high revenues than those using a traditional production planning system did. They were (3) more confident about the decision tasks and (4) more satisfied with the outcomes than those using the traditional system were. Another finding from the experiment is that the subjects spent about 15 minutes watching a demonstration on VIZ_planner and 40 minutes practicing with VIZ_planner after they knew how to use the traditional system. This means that the final visual representations are easy to understand and use. Although they were told that they did not have to use visual representations if they

did not like to, 83.3% of the VIZ_planner users had intensive use of the visual representations during their problem-solving processes.

Reference

Zhang, Ping, Visualization for Decision-Making Support, Ph.D. dissertation, The University of Texas at Austin, 1995.

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